

Claims:

1. A unit-layer post-treatment catalyst  
chemical-vapor-deposition apparatus for forming a thin film  
on a substrate by using the catalyst action of an exothermic  
5 catalyst body resistance-heated in a reactive vessel capable  
of performing vacuum pumping, comprising:  
a gas supply system capable of introducing flow rates  
of thin-film-component-contained gas and hydrogen gas into  
the reactive vessel like a pulse; and  
10 an exhaust system capable of performing vacuum pumping  
and pressure control, wherein  
the above thin-film-component-contained gas and hydrogen  
gas introduced like a pulse contact with the exothermic  
catalyst body and decompose and form a thin film for each unit  
15 layer on the substrate, and form a laminated thin film by  
surface-treating the thin film for each unit layer.
2. The unit-layer post-treatment catalyst  
chemical-vapor-deposition apparatus according to claim 1,  
20 characterized in that  
the surface treatment is one or both of the surface  
treatment by thin-film-component-contained gas excluding  
silicon and containing active species and the surface treatment  
by hydrogen gas containing active species.

3. The unit-layer post-treatment catalyst  
chemical-vapor-deposition apparatus according to claim 1,  
characterized in that

the catalyst performance is regenerated by applying  
5 hydrogen gas to the exothermic catalyst body.

4. The unit-layer post-treatment catalyst  
chemical-vapor-deposition apparatus according to claim 1,  
characterized in that

10 the surface treatment is one or both of the extracting  
treatment of surplus thin-film component and direct adding  
treatment of a thin-film component.

5. The unit-layer post-treatment catalyst  
15 chemical-vapor-deposition apparatus according to claim 1,  
characterized in that

one of nitrogen gas and rare gas is used instead of the  
hydrogen gas.

20 6. The unit-layer post-treatment catalyst  
chemical-vapor-deposition apparatus according to claim 1,  
characterized in that

the thin-film-component-contained gas is made of at least  
one of hydride of silicon and halide of silicon, and at least  
25 one of nitrogen and hydride of nitrogen.

7. The unit-layer post-treatment catalyst chemical-vapor-deposition apparatus according to claim 1, characterized in that

the thin-film-component-contained gas containing active  
5 species in the surface treatment is one or both of nitrogen and hydride of nitrogen.

8. A unit-layer post-treatment film forming method which is a catalyst chemical-vapor-deposition method for forming  
10 a thin film on a substrate by using the catalyst action of an exothermic catalyst body resistance-heated in a reactive vessel capable of performing vacuum pumping, comprising:

an activating step of introducing flow rates of thin-film-component-contained gas and hydrogen gas like a  
15 pulse, bringing the gases into contact with the exothermic catalyst body, and generating active species;

a film forming step of forming a thin film for each unit layer on a substrate; and

a surface treating step of performing surface treatment  
20 of a thin film for unit layer by hydrogen gas containing active species, and another surface treating step of surface-treating a thin film every unit layer by thin-film-component-contained gas including active species, wherein the surface treating step and the other surface treating step can be carried out  
25 in any order; characterized in that

a laminated thin film is formed by using a series of steps for respectively performing surface treatment after forming a film as one cycle, and repeating a plurality of cycles.

5 9. The unit-layer post-treatment film forming method according to claim 8, characterized by repeating one of the one surface treating step and other surface treating step a plurality of times during one cycle.

10 10. The unit-layer post-treatment film forming method according to claim 8, characterized in that  
one or both of the one surface treating step and other surface treating step and a film forming step of forming a thin film for each unit layer on a substrate are continuously  
15 performed.

11. The unit-layer post-treatment film forming method according to claim 8, characterized by vacuum-pumping remaining gas after one of the film forming step, the one surface  
20 treating step and other surface treating step.

12. The unit-layer post-treatment film forming method according to claim 8, characterized in that  
the one surface treating step is a step of extracting  
25 a surplus thin-film component and the other surface treating step is a step of adding a thin-film component.

13. The unit-layer post-treatment film forming method according to claim 8, characterized in that

the final step of one cycle is a step of performing surface treatment by thin-film-component-contained gas excluding  
5 silicon and containing active species.

14. The unit-layer post-treatment film forming method according to claim 8, characterized in that

one of nitrogen gas and rare gas is used instead of the  
10 hydrogen gas.

15. The unit-layer post-treatment film forming method according to claim 8, characterized in that

the thin-film-component-contained gas is made of at least  
15 one of hydride of silicon and halide of silicon, and at least one of nitrogen and hydride of nitrogen.

16. The unit-layer post-treatment film forming method according to claim 8, characterized in that

20 the thin-film-component-contained gas including active species in the surface treatment is one or both of nitrogen and hydride of nitrogen.

17. The unit-layer post-treatment film forming method according to claim 8, characterized in that

25 the thin-film-component-contained gas is made of monosilane gas and ammonia gas, the film forming step forms

a silicon nitride film for each unit layer on a substrate, and the other surface treating step is a step of surface-treating a silicon nitride film for each unit layer by ammonia gas including active species.

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18. The unit-layer post-treatment film forming method according to any one of claims 15 to 17, characterized in that the final step of one cycle is a step of performing surface treatment by ammonia gas which is

10 thin-film-component-contained gas including active species.